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This study attempts to determine the feasibility of the Wild Weasel proposal being made by General Dynamics Corporation. The Investigation covers the NATO threat, a brief history of the Wild Weasel; the capabilityies of the current Wild Weasel (F4G

(F-4G Phantom); [redacted] the capabilities of the F-16 Wild Weasel; and a cost comparison of the F-16 &

and F-4G Wild Weasel Aircraft.

The investigation reveals that an Advanced Wild Weasel is necessary to contend with the Soviet Air Defense System and to be compatible with near-future Allied Fighter Aircraft.

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THE F-16 WILD WEASEL: A FEASIBILITY STUDY

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE

by
Byron L. Huff, Major, USAF
B.S., Northern Arizona University, 1964

Fort Leavenworth, Kansas
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The opinions and conclusions expressed herein are those of the individual student author and do not necessarily represent the views of either the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

THE F-16 WILD WEASEL: A FEASIBILITY STUDY, by Maj. Byron L. Huff, USAF, 55 pages.

This study addresses the role of the surface-to-air missile as it was used in a coordinated air defense system in North Vietnam and in the October '73 conflict in Israel and establishes the concept of the Wild Weasel as viable in modern warfare. It covers the Soviet air defense threat as it now stands and future trends of increasing size and capability.

A history of the evolution of the Wild Weasel mission culminates with a description of the present capabilities and limitations of the F-4G Phantom Wild Weasel. General Dynamics' proposed Wild Weasel version of the F-16 is studied to cover its aerodynamic and electronic advances. A comparison of the F-4G and F-16 Wild Weasel aircraft is made to include a typical mission, range, ordnance load, and survivability. Compatibility of each aircraft operating with today's fighter force is compared with future operations of new generation aircraft of the near future.

The general conclusion is that the F-16 Wild Weasel possesses a quantum jump in maneuverability, survivability, and maintainability. It provides realism to the future of the Wild Weasel mission. Cost is the only area in which the F-4G excels, but this factor is slight and is offset by lower operating and maintenance costs of the F-16 and the fact that exorbitant costs will have to be incurred to update the F-4G to be capable of suppressing the Soviet threat of the near future. In order to maintain the Wild Weasel concept viable, procurement of the F-16 Wild Weasel must be started immediately.

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CHAPTER I

INTRODUCTION

> "...suddenly, there was a dull 'thump,' the aircraft jerked forward, and a tremendous orange flash lit the cockpit and sky....Knocked back in the seat, I said, 'My God, I've had it now!'"
>
> Francis Gary Powers[1]

These were the thoughts of Francis Gary Powers, former USAF pilot, as he was shot down by a Soviet surface-to-air missile over Russia in 1960. He was flying a spy mission in a high-flying U-2 reconnaissance aircraft at the time and was the first of many Americans to be shot down by Soviet air defense missiles.

Since the appearance of aircraft on the battlefield, the progress of military aviation has been paralleled by the development of weapons systems designed to detect and destroy them from the ground. The massive barrages of antiaircraft artillery (AAA) during World War II have given way to complex surface-to-air missile (SAM) systems which were designed to defend against today's advanced supersonic fighters.

For years the vulnerability of aircraft to ground defenses has been low due to their high speed and three-dimensional maneuverability. A hit was predicated on massive barrages of antiaircraft fire in the suspected area of operation. As technology improved, more sophisticated

detection and tracking systems were developed. Radar was perfected and coupled to fire control which greatly increased the accuracy of individual shells. However, the shell itself remained the major flaw in the system. After the projectile left the barrel of the gun, there was no way to change its direction if the aircraft turned. Fighter pilots learned to fly unpredictable flight paths with random changes in direction and altitude to defeat radar directed antiaircraft fire. This maneuver, called a "jink," precluded all but a lucky hit and forced the ground gunners to revert to barrage fire as their primary tactic.

The seriousness of the Soviet surface-to-air missile (SAM) threat became evident the day Gary Powers was shot down. From that day on, whether in actual combat or training, the SAM has been uppermost in the mind of every pilot who must plan a combat mission.

The only time U.S. combat forces have challenged a coordinated air defense system utilizing surface-to-air missiles was during air strikes against North Vietnam. The results forced U.S. tacticians to change deep-rooted ideas on how to defeat, or at least degrade, an enemy air defense umbrella. The SA-2, one of the first SAM systems produced by the Soviet Union, was not perfect by any means. However rudimentary its capabilities by today's standards, it was far more effective than radar guided guns. Instead of a lethal zone measured in a few thousand feet, the SAM had a good chance of hitting an aircraft 10 to 12 miles out and, under some circumstances, engage aircraft flying as much as

19 miles away.[2] Additionally, if the target aircraft changed its course, the fire direction computer would detect the change and continuously guide the missile to the target. This enhanced capability of ground defenses dictated new tactics for American aircrews and electronic warning systems.

Many ideas were exploited to defeat and degrade the missiles and increase the chances for survival. Radar warning devices were installed in American aircraft to warn the crew of a missile launch; violent maneuvers were devised to exceed the tracking capability of the missile; and radar jamming pods were carried to jam tracking radars and "hide" American aircraft. Attempts were made to approach targets from low altitude underneath the radar coverage. Each of these and other attempts to degrade the SAM were partially successful for a time. Improvements of the missile system were made in each instance to counter American tactics. One attempt to suppress the enemy ground defensive systems was the development of a specially equipped aircraft and highly trained crew whose sole mission was to render the SAM and AAA batteries ineffective.

The USAF also began to develop specialized aircraft to deal with enemy defenses.[3] Converted bombers attempted to electronically jam their radars; however, due to their lack of speed and maneuverability, they were very vulnerable and had to remain too far from the threat to be of much value. To compensate for this deficiency, USAF planners placed some of the electronic gear from the bomber-type aircraft into

smaller fighters, which could accompany the strike force at high speed and had the maneuverability to increase their survivability. These "electronic fighters" were to provide timely warning of a SAM launch, be able to locate the camouflaged launch sites electronically, and destroy them with high explosive ordnance.

The first attempt at this mission was given to the North American F-100 Supersabre, the first U.S. supersonic fighter. The two-seat trainer version provided the required room necessary for an electronics warfare officer (EWO) and the specialized equipment, resulting in the combination called the "Wild Weasel." The Wild Weasel, a two-man team in a fighter aircraft, pitted against the SA-2 SAM threat in North Vietnam quickly became a regular component of the USAF offensive strike force.

It soon became apparent that the aging F-100 was having trouble keeping pace with the newer and faster Republic F-105 Thunderchief.[4] Therefore, the two-seat version of the F-105 was modified to accommodate improved electronic gear and became the second generation Wild Weasel.

In addition to the improved electronics and the ability to perform with the strike force, the F-105 carried the AGM-45 Shrike, a Navy developed anti-radiation missile. This added another dimension to the weapon system, a stand-off capability. From outside the SAM's lethal range, the F-105 could detect an emitting radar site and destroy it with a missile which sensed the radar power and "homed" in on the source. As a

counter, the ground radar operators learned to turn off their equipment when the Wild Weasel maneuvered into launch position, a tactic that caused many Shrike missiles to go unguided and miss their target.[5] However, success was still evident as the end result was suppression of the enemy missile capability since they could not fire a SAM at the strike force with the radar turned off.

Because of the success of the Wild Weasel concept in Vietnam, the USAF continued developing newer equipment to complement the current mission. Among the latest developments was a new anti-radiation missile with a longer range and a "memory" enabling it to home in on a radar emitter, even if it was turned off; new jamming pods small enough to be carried on fighters to jam the tracking radars; and new warning receivers to tell the aircrews when a SAM was being launched.[6]

In addition, several McDonnel-Douglas F-4C Phantom two-seat fighters were converted to the Wild Weasel role and assisted the F-105 Weasel in Vietnam until the cessation of hostilities.[7]

Currently, the USAF is phasing the F-105 Wild Weasel out of the inventory and is putting the most advanced radar detectors and locators into the latest model of the F-4 family.[8] The modifications made to the Phantom are so extensive that they constitute a new model, the F-4G. This newest Wild Weasel with its modern electronic system, called the APR-38, coupled with the 20-year-old airframe technology, is programmed to be the sole Wild Weasel aircraft for the foreseeable future.

Since the APR-38 was developed and became an integral part of the new Phantom Wild Weasel system, advances by the U.S. and Soviets have partially nullified the apparent gains of this system. In particular, the Soviets have increased the sophistication of their air defense system, and there has been a quantum leap in aerodynamic design of U.S. fighter aircraft, such as the F-14, F-15, F-16, and F-18. In this paper I will describe the capabilities and limitations associated with the current F-4 Wild Weasel system and suggest an economically feasible solution that will more than adequately achieve the military goals required.

FOOTNOTES

1. Francis Gary Powers. Operation Overflight. (New York: Holt, Rinehart, and Winston, Inc., 1970), p. 82.

2. U.S. Army, Field Manual 90-1, Employment of Aviation Units in a High Threat Environment. (Washington, D.C.: 20 May 77), p. 27.

3. Carl Berger (ed), The United States Air Force in Southeast Asia. (Washington, D.C.: Office of Air Force History, 1977), p. 102.

4. Bobby Beale, Colonel, USAF, HQ Tactical Air Command, Directorate of Requirements, telephone interview, (Apr 79).

5. Julian S. Lake, RAdm, USN(Ret), and Richard V. Hartman, LtCmdr, USN(Ret). "Air Electronics Warfare," U.S. Naval Institute Proceedings. (Oct 76), p. 46.

6. Ibid.

7. Berger.

8. "Wild Weasels Prepare to Fly the F-4G," Electronic Warfare/ Defense Electronics, Vol X. (Jan 78), p. 72.

CHAPTER II

IMPROVEMENT OF THE SOVIET AIR DEFENSE SYSTEM

U.S. Army tacticians rely heavily on the assumption that tactical air support will be available when needed. Almost without exception, their battle scenarios presume that local or temporary air superiority is at least a possibility. Establishment of air superiority is generally defined as relatively free use of the air for whatever purpose needed. Missions that need at least temporary or local air superiority for effective accomplishment are close air support, reconnaissance, electronic intelligence gathering, interdiction, and helicopter operations. Enemy activities which can inhibit these missions by denying free use of the airspace include antiaircraft artillery (AAA), surface-to-air missiles (SAM's), and airborne interceptors. These three coordinated activities comprise the enemy air defense system. To be successful in any air operation, all three portions of this air defense system must be effectively neutralized or degraded to permit mission completion with minimal losses.

The picture that comes to mind when the term air superiority is used generally depicts the Red Baron with scarf flying, engaged in an aerial duel with the best pilot the Fighting Eagle Squadron has to offer. Even though the aircraft and technology have changed, "dogfights" will probably remain an important element in establishing air superiority

over the battlefield. Technology has, however, introduced a less personal method to inhibit air operations: that of guided missiles and radar directed guns. Defense suppression thus becomes an integral portion of attaining air superiority, in particular that which deals with the radar directed surface threat. It should be noted that since interceptors, AAA, and SAM's are used in a closely coordinated effort, any mission involved in establishing air superiority should be able to contend with the threat from any of the three systems.[1]

On 23 July 1965 over North Vietnam, an American aircraft, an F-4C, was shot down by an SA-2 missile.[2] This event was the result of the first combat confrontation between a SAM and American aircrews. These missiles were neither very sophisticated nor accurate and could be countered. If the missile was seen, the pilot could maneuver and avoid it. However, as time went on, technical improvements and formulation of coordinated SAM tactics improved their effectiveness. During encounters with the North Vietnamese SAM's, American aircrews were forced to either jettison their weapons in order to out-maneuver the missiles; concentrate their attention on the SAM, thus allowing interceptors to attack them; or, at the very least, disrupt their concentration, causing them to bomb poorly and miss their targets. Missile firings and the ensuing threat also forced aircrews to fly their aircraft at low altitudes making them extremely vulnerable to AAA guns. Ultimately, these weapons destroyed more American aircraft than any other portion of the North Vietnamese air defense system.[3]

In the most recent confrontation between modern day jet aircraft and a sophisticated air defense system, the Israeli Air Force was pitted against Egyptian and Syrian SAM's, AAA, and interceptors during October 1973. Even though outnumbered three to one by first-line Soviet fighters, the bulk of the 102 Israeli aircraft losses were attributed to surface-to-air missiles (SA-2, 3, 6, and 7) and antiaircraft guns. In addition to these losses, many other aircraft that managed to return to their bases were damaged so extensively as to be irreparable.[4]

Surface Threat

While the United States has been winding down from the throes of the Vietnam War, the Soviet Union has increased military spending.[5] Not only have the Soviets increased the quantity of their SAM systems, but they have introduced equipment with vastly improved capabilities. Their new radar equipment can track an aircraft more accurately and is less vulnerable to electronic countermeasures (ECM). Their missiles are smaller (more difficult to see), faster, more accurate and maneuverable, and have increased range. Many of these systems are mounted on tracked vehicles and, therefore, more mobile. This movement makes them more difficult to locate and enables the SAM's to travel with other surface forces, whom they are to protect. Virtually all systems have an electro-optical option which permits accurate guidance without the use of radar.[6] This eliminates the possibility of being jammed and

decreases the warning of an impending launch. Low altitude capabilities have been significantly enhanced, creating a more difficult problem for aircrews attempting to get "under" the SAM coverage.[7] Two of the new systems use the heat from aircraft engines as a homing signal.[8]

Another factor magnifying the SAM threat is sheer numbers. It is estimated that on any particular day the Soviet Union proper contains 10,000 missile launchers capable of firing 12,000 missiles without reloading.[9] Proliferation of these missiles is extensive in all Russian supplied countries. For example, the Egyptian Air Defense Command has in its arsenal 360 SA-2 sites, 200 SA-3 sites, and 75 mobile SA-6 vehicles. Each site is capable of employing multiple launches before reloading. SA-9 and man-portable SA-7 infrared homing missiles are also in the inventory, but their number is unknown. Combined with 2,850 antiaircraft guns, most of which are radar directed, this system is formidable indeed.[10]

Based on the foregoing, in any battle within a Communist Bloc country one can expect extremely concentrated air defense coverage of all portions of its airspace. All systems working in a coordinated effort would present a threat to aircraft flying from the surface to 90,000 feet and as far as 40 km deep into friendly territory.

Air Threat

The second portion of the Soviet air defense system is its fighter force. Within the last seven years the Soviet Union has introduced five new fighter models and greatly improved older models.[12]

New Models	Improved Models
Mig 23 Flogger C	SU-11 Fishpot C
Mig 23 Flogger D	TU-128 Fiddler
SU-15 Flagon E/F	Mig 21 Fishbed J/K/L/N
Sukhoy Fencer A	SU Fitter C/D
Yak 36 Forger	Yak-28P Firebar

Improvements include increased speed, maneuverability, range, radar capability, and long-range missiles. The Soviet philosophy of mass and proliferation of weapons continues in the development of their airborne defense force, and the quantity of these new fighters is overwhelming. The newest fighters demonstrate advances in Soviet technology: swing-wing models increase flexibility of missions; new radar/missile combinations increase their lethality; and better engines and aerodynamic advances have expanded their performance in acceleration and range.[13]

After examining the combat experiences of the United States in North Vietnam and those of the Israeli Air Force in 1973, it appears that the establishment of air superiority or even air parity against an ever-increasing enemy air defense system will be a difficult task. In order to accomplish this task, effective counters to the defensive systems must be

available to the allied forces. Fighter forces must have every advantage possible built into their weapon system. They will need the gamut of high and low altitude performance, small size, advanced avionics, and maximum maneuverability to provide the capability to meet any surface-borne or airborne challenge the enemy may launch.[14]

Red Flag, a combat training exercise utilizing simulated but realistic "enemy" surface and airborne defenses, has continuously shown that the Wild Weasel is the focal point in establishing air superiority.[15] Their advanced tactics and mature crews have the responsibility to integrate both the air-to-air and the air-to-ground forces. This represents an evolution in thinking by recognizing that the Wild Weasel mission extends beyond interdiction to air superiority as well.[16]

FOOTNOTES

1. William W. Taylor, LtC, USAF, Commander 67th Tactical Fighter Squadron (Wild Weasel), Kadena AB, Japan. Telephone interviews from Oct 78 to Mar 79.

2. Carl Berger (ed). The United States Air Force in Southeast Asia. (Washington, D.C.: Office of Air Force History, 1977), p. 148.

3. Ibid., p. 152.

4. Chaim Herzog, MGen, Israeli Air Force. The War of Atonement. (Boston, Toronto: Little, Brown, and Co., 1975), p. 78.

5. George S. Brown, Gen, USAF, Chairman Joint Chiefs of Staff. United States Military Posture for FY 1979. (20 Jan 78), p. 4.

6. Julian S. Lake, RAdm, USN(Ret), and Richard V. Hartman, LtCmdr, USN(Ret). "Air Electronic Warfare," U.S. Naval Institute Proceedings. (Oct 76), p. 48.

7. Ibid., p. 47.

8. U.S. Army, Field Manual 90-1, Employment of Aviation Units in a High Threat Environment. (Washington, D.C.: 20 May 1977), p. 2-1.

9. U.S. Department of Defense. Annual Report FY72. (Washington, D.C.: 1972), p. 51.

10. "Egyptian Air Defense Command." Electronic Warfare/Defense Electronics, Vol X. (Jan 78), p. 75.

11. U.S. Army, Field Manual 100-5, Operations. (1 Jul 76), p. 8-3.

12. Brown, p. 82.

13. Ibid.

14. "Wild Weasels Prepare to Fly the F-4G." Electronic Warfare/Defense Electronics, Vol X. (Feb 78), p. 71.

15. Ibid.

16. Ibid., p. 72.

CHAPTER III

TODAY'S WILD WEASEL CAPABILITY: ITS LIMITATIONS

The current Wild Weasel, the F-4G Phantom, is a rebuilt and modified F-4E. Extensive tests were conducted to determine a "fatigue index" of certain production aircraft (blocks 42, 43, 44, and 45).[1,2] After determining that the overall stress on these aircraft would probably allow them to have a useful life span upon modification, these aircraft were entered into the Wild Weasel modification program to be redesignated F-4G's.[3] The main difference between the normal F-4E and the Wild Weasel version is the APR-38 radar warning receiver set and associated antennae, computers, and displays. This receiver set allows for the detection, analysis, and location of a radar emitter. Antennae and equipment located in the nose, the wings, and the tail comprise this new system along with the indicators and control panels located in the two cockpits.[4]

The APR-38 is greatly superior to the systems used in the older F-105G and F-4C Wild Weasel aircraft. The radar frequencies capable of being monitored have been increased to include the most recent additions to the enemy SAM threat and their future developmental areas. Its means of locating emitters exhibits the very latest technology. Once the location of an emitter is determined, its coordinates are inserted into an inertial navigation system with a memory bank allowing for exact location recall, if necessary, after

the emitter goes off the air.[5] Upon command, priorities are established within the computer to identify for the crew the most serious threat while operating in a dense environment. The APR-38 is also integrated into the weapons release computer to enable automated bombing of a camouflaged missile site even if it cannot be seen by the crew. All of these systems are necessary to keep the Wild Weasel concept effective when challenged by today's enemy air defense system.

An aircraft like the F-4 is basically a weapons-carrying platform. Whether it is used in an air-to-air or air-to-ground role, it must be structurally capable of carrying enough ordnance to the target, survive the hostile defenses, accurately deliver the ordnance, and return to be reloaded and perform again. A weakness in any one of these capabilities is detrimental to the overall weapons system. Enhancing these capabilities in a fighter aircraft may be accomplished in many ways; for example, to survive the enemy defenses, engineers may design an aircraft that relies on speed, while another may rely on maneuverability, and yet another on size and electronic protection. No matter what advantages or disadvantages it may have, it must be capable of surviving enemy defenses.

The F-4 Wild Weasel relies on sensitive electronic warning devices, primarily the APR-38, to provide timely warning of SAM activity and remain a viable weapons delivery platform in a high threat environment.

Even with all this sophisticated equipment, there are still shortfalls in the current weapon system. A discussion of the modifications incorporated in the F-4G as they relate to the total mission capability follows.

The APR-38 was too large to be installed in the F-4E without the removal of some of the basic equipment.[6] The 20mm cannon with the ammunition storage area was the first item to be removed to make room for the electronics. The loss of this weapon has a great deal more impact than is initially apparent. Although not a primary piece of ordnance in the Wild Weasel arsenal, it provided great flexibility.[7] This 20mm cannon is an effective weapon against air-to-air targets as well as in air-to-ground action.[8] It is mounted internally in the F-4E, thus presenting a lesser penalty in drag than a gun carried externally. Finally, the loss of this weapon may be a detriment to mission accomplishment as it may be the only means by which the crew can ward off an airborne threat.[9]

Additional digressive changes may be considered in modifications to the missile-carrying capability. Most F-4's have four fuselage missile cavities where AIM-7 air-to-air missiles can be carried. By being semi-submerged, they create a minimum drag inflight and, at the same time, permit other ordnance to be carried on the wings. In the F-4G, the two forward cavities have been designed for other equipment.[10] The left forward missile cavity has been replaced by an air-to-ground camera which permits the Wild Weasel to document

bomb damage or accomplish photo reconnaissance. The right forward missile cavity now accommodates a radar jamming pod used for defensive reaction against SAM firings. It can be said that the addition of this equipment has resulted in a reduction in capability of the Wild Weasel to perform against an enemy airborne threat even though the equipment serves an otherwise useful purpose.

Many times the effectiveness of a Wild Weasel mission is predicated on station time and ordnance availability. The following discussion centers on the feasibility of modifications in this area. The F-4 has four wing stations and a centerline station, all capable of carrying weapons. The wing stations can carry multiple high explosive bombs or guided munitions and anti-radiation missiles (Fig 1). Two of the wing stations and the centerline station are able to carry jettisonable fuel tanks when not loaded with weapons.[11] Typically, two of the wing stations carry fuel tanks, and the remaining three are free to carry ordnance. These tanks may be considered a necessity as range is severely limited without the additional fuel they provide. On some special missions where extended distances or a long station time is required, all three fuel-carrying stations may carry fuel tanks rather than ordnance, thus leaving only two bomb-carrying stations.

Any mission degraded because of speed or maneuverability must be compensated for by other means to insure survival. This is a problem with the converted F-4G as discussed in the following paragraph.

The effort to make the F-4E more maneuverable at low airspeeds and/or high angles of attack has caused an ensuing problem at the other end of the speed and handling spectrum. Leading edge slats (LES) were added to improve the handling characteristics of the F-4 and make it less susceptible to spin. However, they are basically inoperable above 450 knots -- where Wild Weasel combat profiles are performed. Thus, speed above 450 knots provides the most difficult tracking problem for enemy missiles and guns. Therefore, it may be said that the presence of slats in the F-4G is not beneficial due to adding weight and drag, detracting from its ability to accelerate, and thus causing higher fuel consumption.

Another inherent limitation of the F-4, a problem identified years ago, is the problem of smoking engines. Smoke coming from a fighter enables it to be seen as much as ten times as far away when viewed from certain aspects. The visual tracking capability of SAM systems are given an advantage when they are combating a large aircraft which smokes heavily. Enemy interceptor pilots also enjoy this advantage.

Sample Mission Profile

A model of an average Wild Weasel mission flying from point A to point B (in a combat zone), performing its defense suppression task, and returning to point A, will provide a data base from which a comparison can be made later in the paper. This model does not depict any particular location or any particular tactics, but rather a sampling to depict mission capability.

The specific job is to provide suppression of enemy SAM activity in a limited area in support of an interdiction mission performed by other strike aircraft. The Weasel will travel 100 nautical miles from takeoff, descend to low altitude for 90 nautical miles to the target area. It will depart when the fuel state requires and will remain at low altitude for 50 nautical miles, then climb to optimum altitude for the remainder of the recovery (Fig 2).

The aircraft configurations for this model mission will consist of two external wing tanks, two AGM-45 Shrike anti-radiation missiles (air-to-ground) on the inboard stations, four cluster bomb type munitions on the centerline, the ALQ series radar jammer, and two AIM-7 Sparrow missiles (air-to-air) carried in the fuselage stations.

Computations from the F-4G flight manual mission planning charts show that the F-4G can fly this mission profile and remain in the target area providing defensive warning and suppression for the strike aircraft for 3.9 minutes. These figures do not provide for afterburner use. Enemy SAM or interceptor reaction would probably necessitate the use of afterburner for more thrust, which increases the fuel consumption by a factor of four.[12]

This model shows that if the Wild Weasel is to be used according to doctrine, that is, first in the target area and last to leave, extremely precise mission planning, coordination, and execution are required for success. Simply adding fuel tanks will not solve the problem, because that

option results in too little ordnance carrying capability to be effective.

Growth Capability

After discussing the growth problem with the people who are involved in the F-4G Wild Weasel test program, several factors became evident. In the original design of the avionics package for the F-4G, some desirable but not critical electronics had to be left out due to space limitations. Computer space is limited and operation of the APR-38 associated systems as they are now configured challenges the current computer capacity. Studies are ongoing to increase the capability of the main computer at this time. In the testing for a new High Speed Anti-Radiation Missile (HARM), it is becoming apparent that some equipment will have to be removed to provide space for the associated electronics.[13]

It should be noted that at the time the avionics of the original F-4 was conceived, the latest technology consisted of bulky tubes and large wiring harnesses. The present solid-state technology using transistors, integrated circuits, and other advances has made the F-4G possible. Further growth of capabilities may depend on further advances in miniaturization.

Cost Per Unit

When discussing military procurement costs, there are many variables that make comparisons difficult. This difficulty

increases when addressing a rebuilt weapons system such as the F-4G. The problem arises in assessing costs for a basic airframe which was conceived more than 20 years ago and built approximately 10 years ago. The cost of a basic F-4 has gone from $2.5 million at its inception to an excess of $6 million at the present time.[14] For simplification, the data in this study will refer to the cost of $5 million for the F-4E produced in 1968.[15]

There are actually three sub-costs to consider in order to arrive at a total cost for the F-4G weapons system: the original airframe; the APR-38 warning receiver (which includes research, development, and procurement); and, the labor to dismantle and modify the aircraft and install the new equipment.

Tactical Air Command project managers have identified the following F-4G costs: procurement and other costs for the APR-38, $3.25+ million per aircraft, with labor coming to $.169 million, for a grand total of $3.43 million for each aircraft (Fig 2). When the original purchase price of $5 million is added to these figures, each F-4G is priced at $8.68 million. This figure includes $.25 million allocation to replace the inertial navigation system, which is to provide the necessary accuracy for compatibility with the other Wild Weasel equipment and other costs involved in procurement (Fig 3).

F-4 WEAPONS

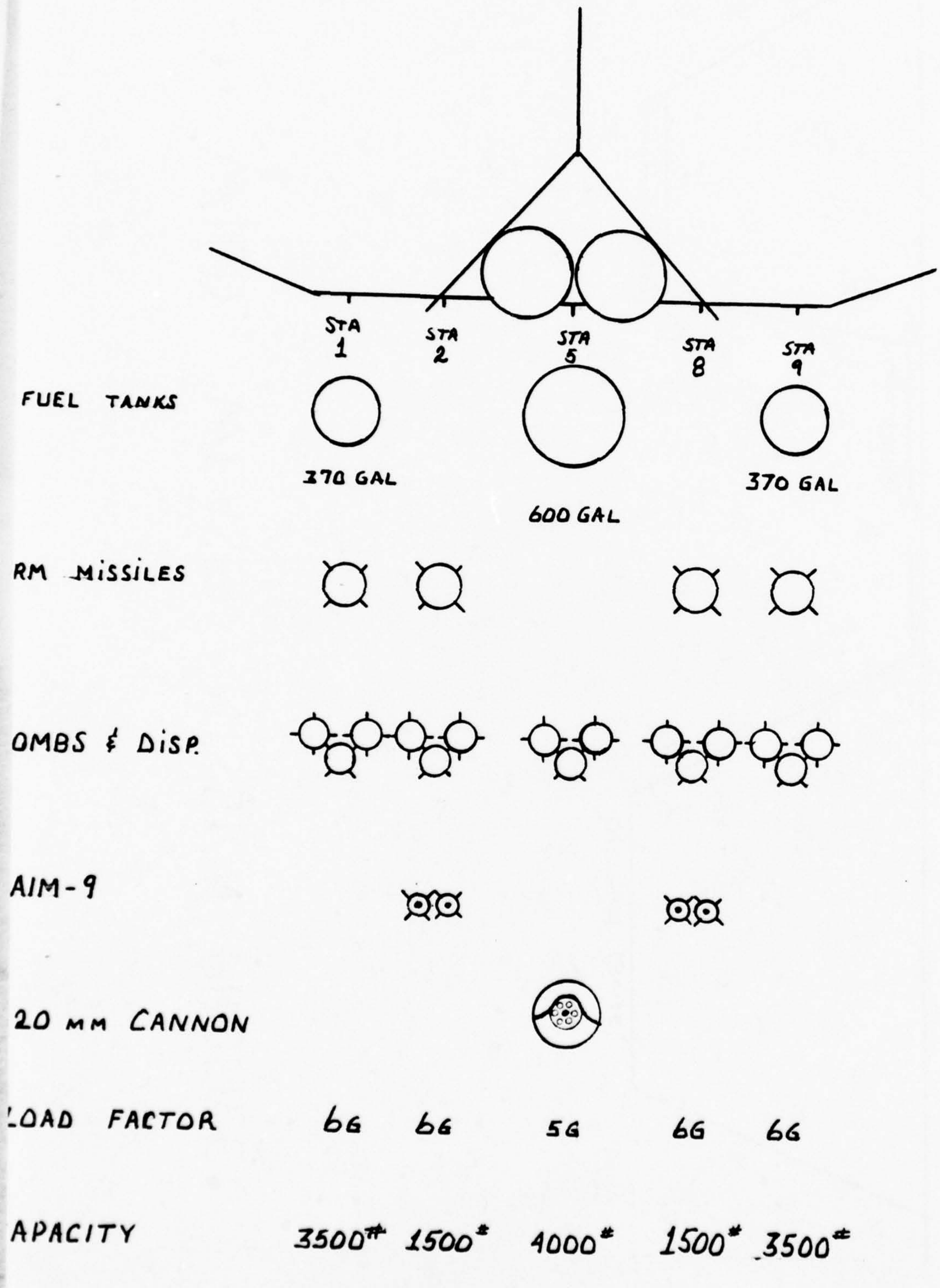


FIG. 1 . . SOURCE: T.O. 1F-4G-1

WILD WEASEL MISSION PROFILE

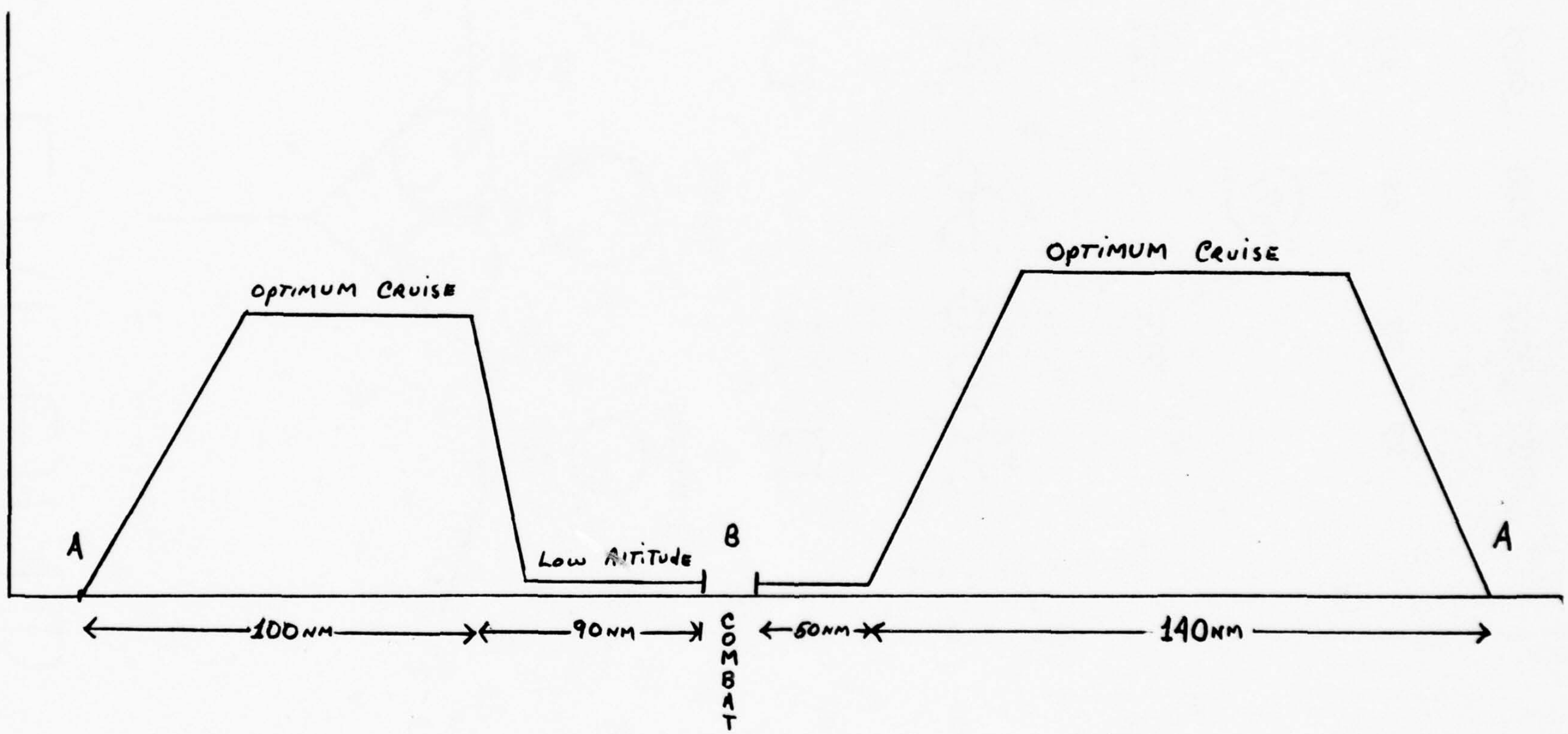


Fig 2 Source: T.O.1F-4G-1

F-4G Wild Weasel (WW)
Data Sheet***

	UNIT COST	TOTAL COST*		
	THEN YEAR		CURRENT ESTIMATE	PM THRESHOLD
FY 80 POM			THEN YEAR	THEN YEAR
Flyaway (Gp A&B)	1.38M	RDT&E	$ 78.5	$ 78.9
Procurement	2.58 ←	PROC (116 Acft)		
Program Acq	3.43	– 3010 (Acft)	293.8	
		– 3020 (Msl)	0.4	
		– 3080 (SE)	1.2	
		– 4921 (Stock Fund)	3.8	
		– 3400 (Labor)	19.7	
		Total	$318.9	350.0
		PROGRAM ACQ	397.4 -3.43	429.8

FY 80 POM

	FY 77 & Prior	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	TO COMP	TOTAL
RDT&E (3600)	78.5	2.0**	2.0	2.0	5.0	5.0	5.0	5.0	Cont	Cont
PROC (3010)	230.9	4.3	58.6							293.8
Kit Proc	120.3		39.7							160.0
Support Eq (P)	22.6	1.2	12.2							36.0
Support Eq (C)	1.7									1.7
Data	19.7	0.3								20.0
Trainer	9.7		5.8							15.5
Tooling	20.7									20.7
Non Rec	16.1	2.8								18.9
Initial Spares	20.1		0.9							21.0
Total (3010/3600)	309.4	4.3	58.6					TOTAL PROCUREMENT →		372.3
P4921 Stock Funds	2.3	0.8	0.6	0.1						3.8
3020 Loaders	0.3	0.1						OTHER COSTS →		0.4
3080 Support Eq	1.2									1.2
Labor (3400)	1.6	5.1	6.4	5.4	1.2			LABOR →		19.7
Qty Buy	87		29							116
Del (By FY)	1	21	35	36	23					116
Cum Del	1	22	57	93	116					116
Invent UE		12	42	75	96					96
Total Program	314.8	10.3	65.6	5.5	1.2					397.4
FY 79 PRES BUD	314.5	10.2	65.3	5.2	1.2					396.4
RDT&E	78.5	2.0**	2.0	2.0	5.0	5.0	5.0	5.0	Cont	Cont
3010 Mod	230.9	4.3	58.6							293.8
Total (3010/3600)	309.4	4.3	58.6							372.3
P4921 Stock Fund	2.3	0.8	0.6	0.1						3.8
3020	0.3	0.1								0.4
3080	1.2									1.2
3400	1.6	5.1	6.4	5.4	1.2					19.7
Qty Buy	87		29							116
Total	314.8	10.3	65.6	5.5	1.2					397.4

*Reflects cost to develop and acquire 116 F-4G aircraft (basic configuration) under Program Memorandum #4.

**Initial funding for threat updates; not part of PM #4 program.

***Funds to replace the F-4G INS (at OSD direction) are identified in the Class IV modification section of PE 27128F (FY 78 1.0; FY 79 9.0; FY 80 2.0; FY 81 7.5; FY 82 11.7; Total 31.2). These funds are excluded from this data sheet becuase the INS program is not part of the PM #4 program.

Fig 3.

SOURCE: HQ TACTICAL AIR COMMAND, DRAV, MAJ JOHNSON.

FOOTNOTES

1. "New Weasel Aircraft Will Play a Vital Role." Electronic Warfare/Defense Electronics, Vol X. (Feb 78), p. 76.

2. U.S. Air Force, Technical Order 1F-4G-1 Flight Manual. (1 Oct 77). Identifies production block numbers converted to F-4G models, p. iv.

3. "New Weasel Aircraft Will Play a Vital Role," p. 75.

4. U.S. Air Force, Technical Order 1F-4G-1, p. F.O. 20 and 21.

5. William W. Hillman, Capt, USAF, Wild Weasel Instructor Pilot, Flight Commander, 39th Tactical Fighter Squadron, George AFB, California. Telephone interviews from Sep 78 to Apr 79.

6. Ibid.

7. Peter M. Graff, LtC, USAF, Wild Weasel Pilot, former Commander 67th Tactical Fighter Squadron, Kadena AB, Japan. Currently assigned HQ Tactical Air Command/ DRAV, Langley AFB, Virginia. Telephone Interviews 78-79.

8. Albert P. Clark, III, Maj, USAF, Wild Weasel Pilot, former Chief of Standardization and Evaluation, Kadena AB, Japan. Currently assigned to Tactical Fighter Weapons Center, Nellis AFB, Nevada. Numerous telephone interviews on currency of tactics and use of different weapons for specific missions from Sep 78 to Apr 79.

9. William W. Taylor, LtC, USAF, present Commander 67th Tactical Fighter Squadron, Kadena AB, Japan.

10. U.S. Air Force, Technical Order 1F-4G-1, p. 5-14.

11. Ibid.

12. Ibid., p. 1-2.

13. Hillman.

14. J. O. Johnson, Maj, USAF, HQ Tactical Air Command, DRAV, Langley AFB, Virginia. Telephone interviews Sep 78 to Dec 78.

15. Ibid.

CHAPTER IV

F-16: POSSIBLE REPLACEMENT

Since the end of World War II, American fighter aircraft have been technically superior to those manufactured abroad, but have suffered a disadvantage in performance. American aircraft have traditionally exhibited numerous safety devices, life support systems, armor plating, back-up systems, et cetera. Due to this concern for American fighter pilots and the superior (but heavy) weapons control systems, the U.S. aircraft have generally experienced a disadvantage in actual aircraft performance. Thus, American pilots have had to rely mainly on superior training and ingenuity to defeat the enemy.

Our latest generation of fighter aircraft exhibit a long list of improvements which have reversed the "performance gap" previously noted. Manufacturing methods have enabled the American aircraft industry to construct durable fighters of less weight by using stronger, lighter materials; miniaturized avionics components; and lighter, more powerful and more efficient engines. These advances have enabled the U.S. to produce an aircraft with superior performance qualities without sacrificing pilot comfort and safety.

The F-16, one of these new generation fighters, was originally designed to fill the need for a lightweight fighter.

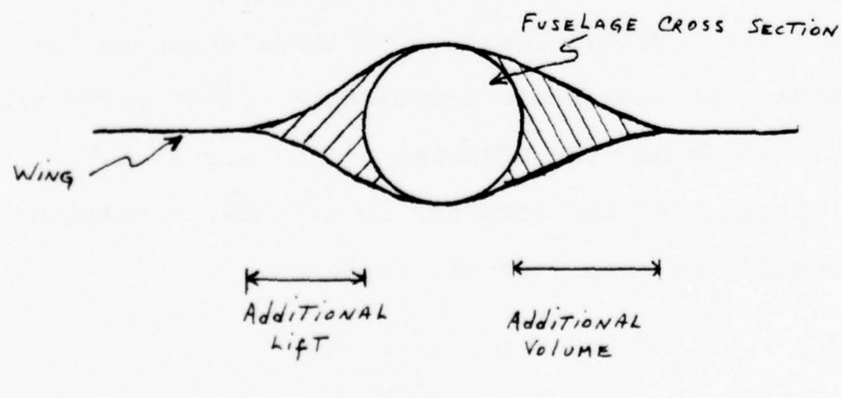
Small, extremely maneuverable, and relatively inexpensive, the F-16 exhibits advanced concepts in aerodynamics, avionics, and engine technology which have resulted in a radically different aircraft.[1] As its capabilities were realized, the F-16 mission changed to that of a "swing" fighter, one which could support air-to-ground equally as well as air-to-air missions. It is now destined to replace the aging F-4 Phantom as the mainstay fighter of the USAF.

After establishing the F-16 as a "swing" fighter and demonstrating its capabilities in both air-to-ground and air-to-air missions, knowledgeable officials at General Dynamics saw an ideal platform for the Wild Weasel mission. Since that point a complete Wild Weasel version of the F-16 has been designed and proposed to the USAF as a follow-on defense suppression airframe. This proposed Wild Weasel will exhibit all of the advanced concepts evident in the fighter version.

One of these advancements is a concept which had been previously found only in research aircraft: the "fly-by-wire" flight control system. This system eliminates the use of pulleys, rods, bell-cranks, and cables to move the flight control surfaces. Instead, signals from the pilot travel electronically through a computer and then, by wire, to the control surfaces. The result is reduced weight, even when three back-up systems are added for safety and better resistance to battle damage.

The computer incorporated in the "fly-by-wire" system permits another new dimension in aircraft design termed "relaxed static stability." Traditionally, maneuverability and stability have been considered at opposite ends of the scale for aircraft design. In order to have a maneuverable fighter, some of the stability had to be sacrificed. However, if too much stability was given up, the pilot would have extreme difficulty in controlling the aircraft. With the fly-by-wire control system, the aircraft can be designed with less inherent stability (more maneuverable), since a computer assists the pilot in controlling the aircraft.[2] The ultimate result is an aircraft which is extremely maneuverable, but totally controllable by the pilot. An additional benefit is reduced drag permitting greater range, better acceleration, and the ability to maintain airspeed while maneuvering.

Another concept which is new to fighter design is the "blended wing-fuselage." This provides a dual benefit: first, greater internal volume to be used for fuel or avionics; and second, a fuselage which produces a portion of the total lift.[3]



The cockpit design and canopy arrangement also exhibit the latest technology. The pilot's seat is canted backward at a 30 degree angle, and the heel rest line is raised about 15 inches. This feature enhances the pilot's ability to pull "g's" or turn tighter without "blacking out," a phenomenon caused by the blood rushing to the feet and reducing the flow to the eyes. The canopy is a true bubble type with no canopy bows in front of the pilot to obstruct his view, resulting in superior visibility.

The weapons capability of the F-16 covers the entire spectrum of the air-to-ground ordnance (Fig 1). It is also capable of employing AIM-9 Sidewinder air-to-air missiles and even in the proposed Wild Weasel version has the 20mm cannon. To carry these weapons, the proposed F-16 Wild Weasel has been designed with seven stores stations, three on each wing and one centerline. The non-Wild Weasel F-16 also has two AIM-9 missile stations on the wingtips, but on the Wild Weasel model these stations contain antenna pods for the APR-38.

The APR-38 to be installed in the proposed F-16 Wild Weasel is essentially the same system developed for the F-4G; however, the antennae were placed on the wingtips instead of the fuselage. The physical location of these antennae has provided a distinct and measurable increase in APR-38 performance. There is no fuselage or wing blanking of the signal in maneuvering flight, and the accuracy in azimuth, elevation, and range location is significantly improved.

All avionics in the F-16 function through the main aircraft computer. With more information available to the APR-38, the accuracy of locating radar emitters is enhanced, and the possibility of error-causing malfunctions is decreased as one subsystem can monitor another for accuracy. Follow-on electronics for the Wild Weasel can be added in the future without a re-design of the entire system, as only minor re-programming of the main computer would have to be accomplished. Future threat coverage as well as realistic training programs could be expanded in the same manner.[4]

General Dynamics studied U.S. military combat data from North Vietnam strike missions. Loss rates of all fighter aircraft involved were plotted against size factor and showed that the smaller the aircraft, the lower the combat loss rate. Using this criteria, projected F-16 combat losses should be about 60 per cent of that of the F-4 under similar combat situations (Fig 2).[5] This is no surprise to any fighter pilot who has participated in free play air-to-air combat with an aircraft smaller in size than his own. Disregarding other factors, smaller size produces a greater tactical advantage.

In dealing with a visually directed ground threat, small size also produces an advantage in stealth and provides less reaction time as detection range decreases. The same is true when addressing radar threats. Smaller aircraft provide less radar reflection and, therefore, are more difficult to detect at any range.

Visual detection ranges are affected by engine smoke and, unlike the F-4, the turbofan engine in the F-16 produces almost no smoke in any flight regime.

Total performance includes all factors of an aircraft's capability and how they compliment or detract from each other. Generally, when an aircraft is modified, it increases one capability at the expense of another. The F-16 is no exception. When the APR-38 antennae were positioned on the wingtips of the Wild Weasel, the loss of the two AIM-9 Sidewinder missile stations was one result, but there have been few other compromises.

In the past, when a two-seat version of a single-seat fighter was built, the two-seat version was generally heavier and had less fuel than its smaller counterpart. But, when the USAF decided to procure the two-seat version of the F-16, it specified that the fuselages were to be identical to reduce cost. The outcome was that the fuel capacity of the single-seat version actually increased due to "stretching" the body, resulting in a disparity in fuel capacity between the two versions.[6] However, the dual cockpit model actually weighs less at takeoff, so performance factors are still similar (Fig 3).

Sample Mission Profile

The intent to portray a mission profile similar to the one used in Chapter III for the F-4G has been hampered due to the information being classified. However, by using

comparison bar graphs used by General Dynamics in publicity materials, an inference can be made to estimate maximum unrefueled range for a typical mission. In Figure 2 we see that in an air-to-surface role the F-16 has approximately two and one-half times the range of the F-4. The combat radius of the F-4G was established in Chapter III as 190 nautical miles; therefore, the F-16 Wild Weasel should be able to provide defense suppression for a range of approximately 475 nautical miles.

Growth Capability

The F-16 was originally designed with growth potential as a major factor. The main aircraft computer system provides an ideal means to integrate future electronics packages into the aircraft with minimum redesign. Also, as future enemy threats appear, the computer can be easily programmed to process and prioritize them. Programs can also be written so that aircrews can use friendly radars for training with the computer displaying them as an enemy radar would actually appear.

Another requirement for growth is available volume to accommodate additional equipment. The F-16 has 5.8 cubic feet in the fuselage designated as "growth space." In addition to this volume, a dorsal spine has been designed which provides an additional thirty cubic feet of volume along the top of the fuselage which can be used for either fuel or avionics. Wind tunnel tests have shown that this spine has

improved the aerodynamic qualities of the aircraft significantly and may be incorporated in the basic F-16 fighter.

On the drawing board at this time are several new engines with more thrust, larger caliber cannons for internal mounting, and radar guided air-to-air missiles (already flight tested and actually fired). In addition, flight tests are underway to upgrade the precision strike capability of the aircraft using the latest "smart bomb" technology.

Cost Per Unit

It is only a bit simpler to address the cost of a new aircraft. Unlike the F-4G, the F-16 Wild Weasel would be constructed with all the associated electronic equipment built in which eliminates the labor expenses for modification. According to the USAF comptroller's figures in their summary for aircraft systems (SAR) dated 31 December 78, the flyaway cost of the basic F-16 is $8.1 million based on a total purchase of 1,388 aircraft.[7] This price is based on money actually appropriated and includes estimated inflation throughout the production period. "Flyaway" costs include engine, electronics, armament, non-recurring costs, and allow for engineering changes during production. The research and development, ground support, training equipment, et cetera, were not included because the majority of that cost will be covered in the programmed F-16 "buy."

According to the Program Memorandum used by Tactical Air Command Requirements Division, the procurement cost of

the APR-38 radar detection system is $2.58 million. This does include ground support, training, and publications needed to support this system.

A projected total cost of an F-16 Wild Weasel aircraft is, therefore, $10.68 million. This cost would be reduced somewhat if a Wild Weasel program is authorized due to the unit F-16 cost being lowered by a larger purchase.

THE F-16 WILD WEASEL ORDNANCE LOAD

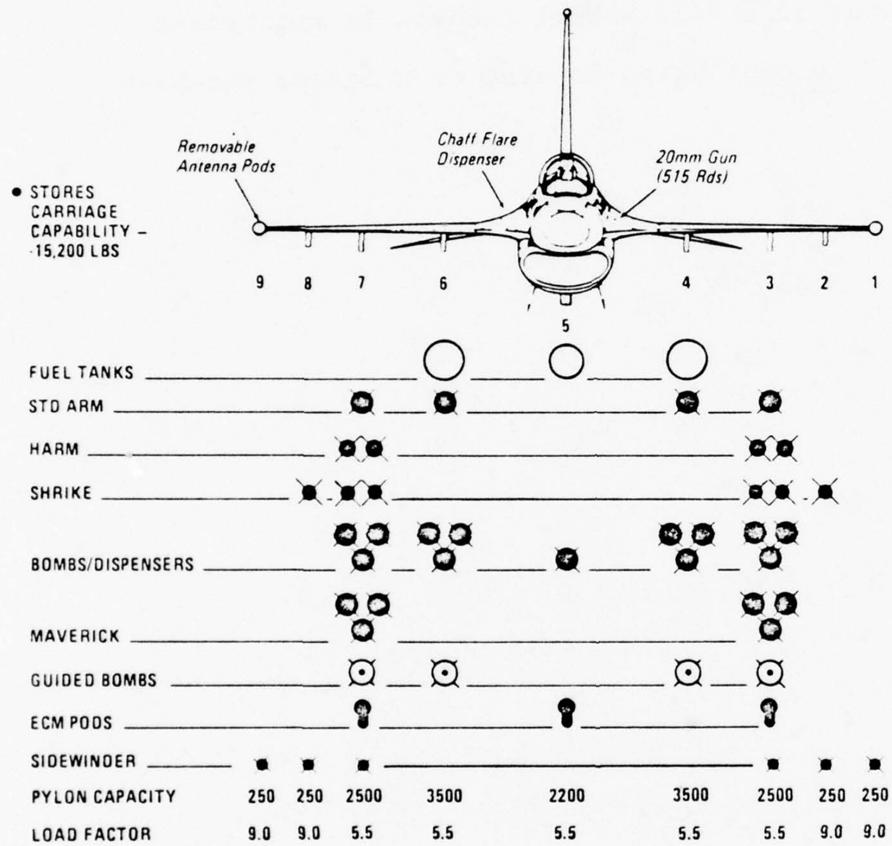
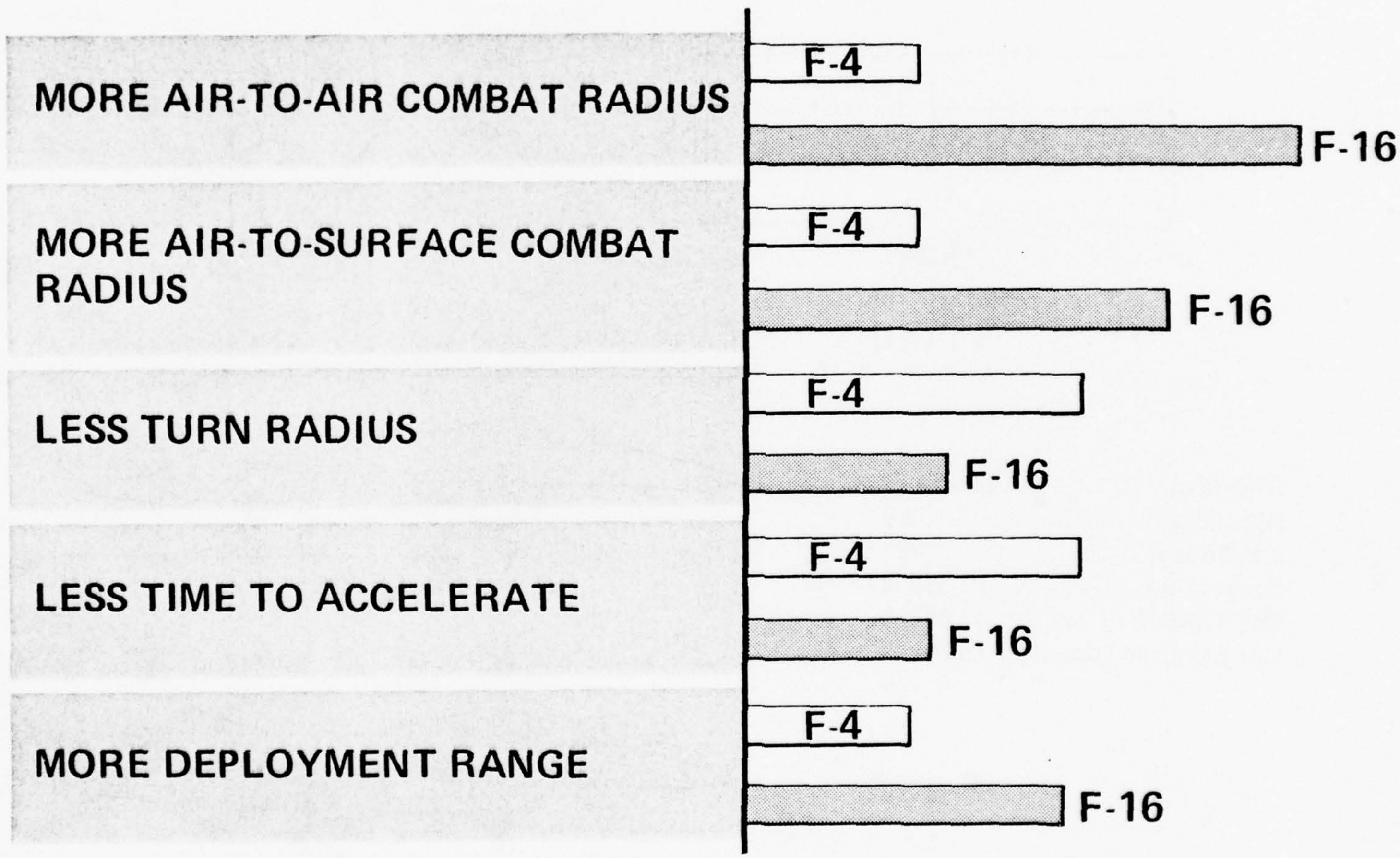


Fig 1

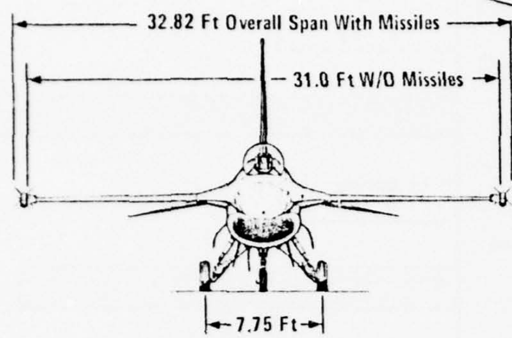
F-16'S HIGH MULTI-MISSION PERFORMANCE

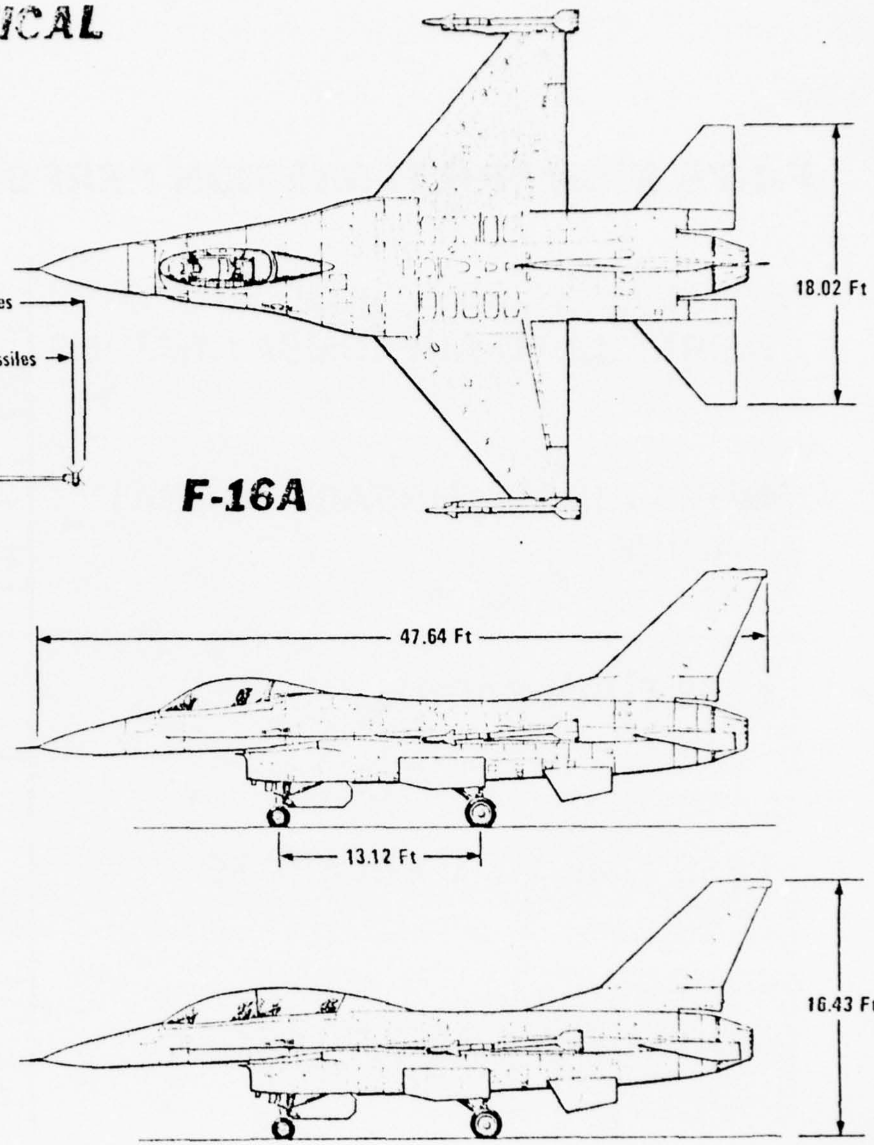


GENERAl DYNAMICS 77 FW/76/100-8340A

Fig 2_{37}

F-16A & F-16B ARE IDENTICAL DIMENSIONALLY





Wing Area . . . . .300 Sq Ft
Aspect Ratio 3.0
L.E. Sweep. . . . . .40°
Design T.O.G.W . . . . . . 22,500 lb
Max T.O.G.W.. . . . . 33,000 lb
Max Ext Load Capacity . 15,200 lb

F-16B

GENERAL DYNAMICS 77

Fig 3.

FOOTNOTES

1. General Dynamics Corp., Fort Worth Division. F-16 Multirole Figher. (Ft. Worth: 1977), p. 21.

2. Thomas Clark, General Dynamics, former Project Manager for F-16 Wild Weasel. Hosted author's visit to General Dynamics. (Ft. Worth: Jan 79).

3. General Dynamics Corp., Fort Worth Division. F-16 Multirole Fighter: Selected Technical Papers. (Ft. Worth: May 1977), p. 166.

4. Clark.

5. General Dynamics Corp., Fort Worth Division. F-16 Utilization in Peacetime and Wartime. (Ft. Worth: May 1977).

6. Clark.

7. Donald Westerheide, General Dynamics, current Project Manager for F-16 Wild Weasel. Telephone interviews concerning cost for F-16 Wild Weasel and on release for use of General Dynamics illustrations. (Apr 79).

8. J. O. Johnson, Maj, USAF, HQ Tactical Air Command, DRWP. (1978).

CHAPTER V

CONCLUSIONS

Although employing a 15-year-old airframe, the F-4G is just entering the operational inventory and can be compared fairly with the F-16, an aircraft which can utilize basically the same electronic package and be in production by the early 1980's.

Both the F-4G and the F-16 are capable of performing the defense suppression mission as it exists today. Variations of capability become evident when evaluating how well each can perform certain tasks and how well they can perform them in the near future.

Combat range is an important factor in considering the capabilities of any combat aircraft. When addressing a mission that is supportive and necessary to the main strike force, it is even more important. In World War II one of the factors in the outcome of the Battle of Britain was the limited range of fighter cover for the Luftwaffe bombers. German losses skyrocketed past the point where the bombers could be escorted.[1] The effectiveness of allied bombing deep in German territory was not effective until the advent of long range escort fighters which could accompany the bombers all the way to the target and provide protection from enemy aircraft.[2]

The F-4G is currently capable of providing defense suppression support to the European/NATO theater of operations because the bulk of the strike aircraft will be F-4 Phantoms with similar range limitations. However, with the introduction of the newer F-15 and F-16 fighters with combat ranges two to three times that of the F-4, it will be extremely difficult to adjust the F-4G procedures and tactics to be compatible. More fuel tanks will have to be carried, reducing the ordnance load, or air refueling will have to be accomplished, which will then necessitate more precise flight planning and execution to insure rendezvous with the strike force. This factor could determine the outcome of any particular air strike. The F-16, with the Wild Weasel configuration, would obviously not have this problem and, with its additional ordnance stations, would be able to operate with the near-future fighter force without sacrificing ordnance.

The anticipated intensity of the enemy air defense in any future conflict is so high that defense suppression activities must be performed quickly and accurately to be effective. The APR-38, the prime electronic Weasel system in both the F-16 and F-4G, provides similar capabilities in each. The F-16 Weasel does exhibit a higher degree of accuracy in a shorter period of time due to the two widely separated antennae (versus one in the F-4G). This reduced exposure time and the improved accuracy of the F-16 bombing avionics provides a higher probability of destroying the target.

The F-16 Wild Weasel also has a better chance of surviving on future battlefields due to smokeless engine, smaller size, better visibility, more firepower with greater accuracy, and better maneuverability. Both aircraft are capable of utilizing the Shrike anti-radiation missile and other stand-off weapons, but new weapons currently under development may present a problem for the Phantom Weasel due to its limited capability for avionics growth.

The F-16 is 60 per cent the size of an F-4 when viewed from an angle. This size difference makes it more difficult for visual acquisition by interceptor pilots, visually directed AAA, and visually guided surface-to-air missiles (used in an electronic jamming environment). The smaller size also limits the detection range of enemy radars. This gives the enemy a shorter reaction time when attacked and degrades his effectiveness.

Ability to defeat the threat, once engaged, is enhanced by early detection and maneuverability. Since both aircraft are using the APR-38 as radar warning devices, the radar detection in both should be equal. Visually directed fire presents no electronic warning and must be seen to be avoided. The superb cockpit/canopy arrangement of the F-16 clearly gives the F-16 crew the edge in early detection of ground fire or engagement by hostile fighter aircraft.

Once the SAM or enemy fighter is detected, it must be outmaneuvered. The F-16, due to its advanced aerodynamic and engine technology, is far superior to the F-4G. In addition,

the capability to add air-to-air ordnance to the F-16 and the built-in 20mm cannon provide the firepower needed to discourage enemy air attack.

It would be extremely unrealistic to think that all combat aircraft would be capable of performing the defense suppression mission and always successfully elude enemy firepower. Size of the target aircraft is definitely related to the probability of being hit by enemy gunfire. Studies show that the F-4 will sustain a hit 1.8 times as frequently as an F-16 in similar combat situations (Fig 1). Once hit, the vulnerable areas determine the ability to tolerate the damage and return to base to be repaired (Fig 2). General Dynamics has evaluated the F-16 using Air Force Systems Command methodology, and results show that the F-4 is 2.4 times more likely to be shot down, if hit (Fig 3). When both of these factors are viewed together, the F-4 is four times more likely to be shot down and destroyed than the F-16 (this study addressed only the 23mm AAA as the threat).

The growth potential is a factor that demonstrates the future use of the aircraft. If an aircraft begins its life span at the limit of its capabilities, it can, and will, be outmoded in a short period of time. The F-16 has an excellent potential for growth due to the ease of reprogramming the computer system to accommodate advances in technology. It also has, in the dorsal spine, additional space for any required electronics packages. In contrast, the F-4 has little available space, and additional avionics eqiupment would require

extensive re-design of the aircraft, an expensive proposition.

Cost is always a critical factor in aircraft procurement. Recent highly capable aircraft have been dropped from future military plans due to their astronomical cost. Military planners must continually evaluate the threat and the budget constraints to produce weapons that are effective without bankrupting the government.

Originally, the F-16 was to reverse the trend towards more expensive fighter aircraft. The target was a low flyaway price and low operating expenses through low fuel consumption and high reliability. The results have been very successful in that the target flyaway price tag has not changed appreciably since its beginning, and the maintenance and fuel costs have proven to be very low. The price of the F-4G is $8.68 million versus the $10.68 million projected price tag on a new F-16 Wild Weasel. The cost advantage has to go to the F-4 on the grounds that the F-4 is already bought and paid for; however, its capabilities will be exceeded in the near future, resulting in costly re-design, procurement of a new Weasel aircraft, or a loss of defense suppression capability.

In examining operating cost, the F-16 has a distinct edge. Even when using a fuel price of 42.3¢/gallon, which is in itself outdated, the savings amounts to $2.82 million per squadron. With fuel prices rising as they have been, this figure will increase proportionately (Fig 4).

Maintenance costs also give the F-16 an advantage. The F-4 has historically required 35 man-hours of maintenance for every hour of flight time. The target required by the USAF for the F-16 is 15 man-hours per flight hour, and General Dynamics expects to better that figure due to the reliability of the aircraft systems. These smaller maintenance requirements can be used in several ways. Maintenance costs can be reduced by 45 per cent without reducing flight time (training), or flight time can be increased with no additional cost. It also provides a surge capability, a greatly increased combat sortie rate, to provide more combat power during war.

The F-16 is a multi-national fighter with the United States a participant in co-production agreements with the Netherlands, Belgium, Norway, and Denmark. This co-production could become a decisive factor in a NATO conflict. Repairs, to include manufacture of some major components, could be made by these NATO countries and save the time required to ship the aircraft back to the U.S. Servicing, to include loading ordnance, could be accomplished at foreign bases, greatly increasing the flexibility of U.S. air operations.

In conclusion, the F-16 Wild Weasel proposal offers a substantially increased capability in the performance of the essential defense suppression mission. Its increased range and performance are compatible with the increasing enemy threat as well as the expanding capabilities of American fighter aircraft. The potential for growth insures a long life span that can be easily molded to deter the

future enemy threat. Flyaway costs are higher than the most recently procured Weasel aircraft, the F-4G; however, maintenance and operating costs are substantially lower. Ultimately, the cost of the F-4 Wild Weasel will exceed that of the F-16 due to major modifications which will be required to modify it to keep pace with the increasing threat.

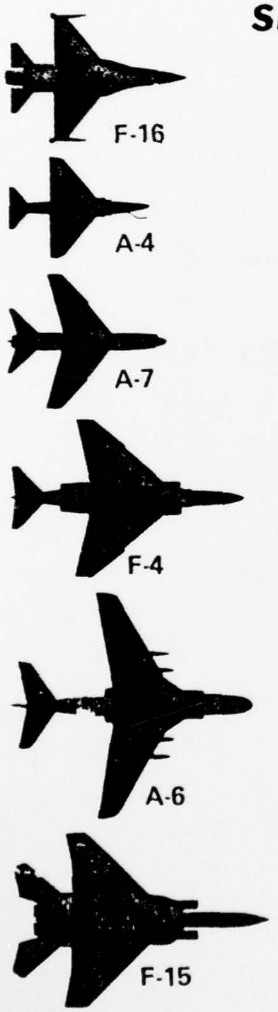
In the near future, the viability of the American fighter force may depend on the effectiveness of the defense suppression mission. If the F-4G remains as the mainstay Wild Weasel, the superiority of the new generation of fighters may be seriously challenged due to the inadequate support tendered by the Phantom.

The General Dynamics Corporation has the capability in their Fort Worth plant to begin construction of the Wild Weasel with no impact on the USAF or foreign military sales delivery schedule and begin delivery in fiscal 1982.[3]

These facts, when compared to the long range cost effectiveness of the F-16 Wild Weasel and the increasing importance of the defense suppression mission, demands that at the very least, a small purchase of eight to ten aircraft should be made to pursue testing and validation of the F-16 Wild Weasel capabilities. After flight tests verify the feasibility of the F-16 Wild Weasel, maximum efforts should be made toward upgrading the Weasel force.

F-16 Will Have High Combat Survivability

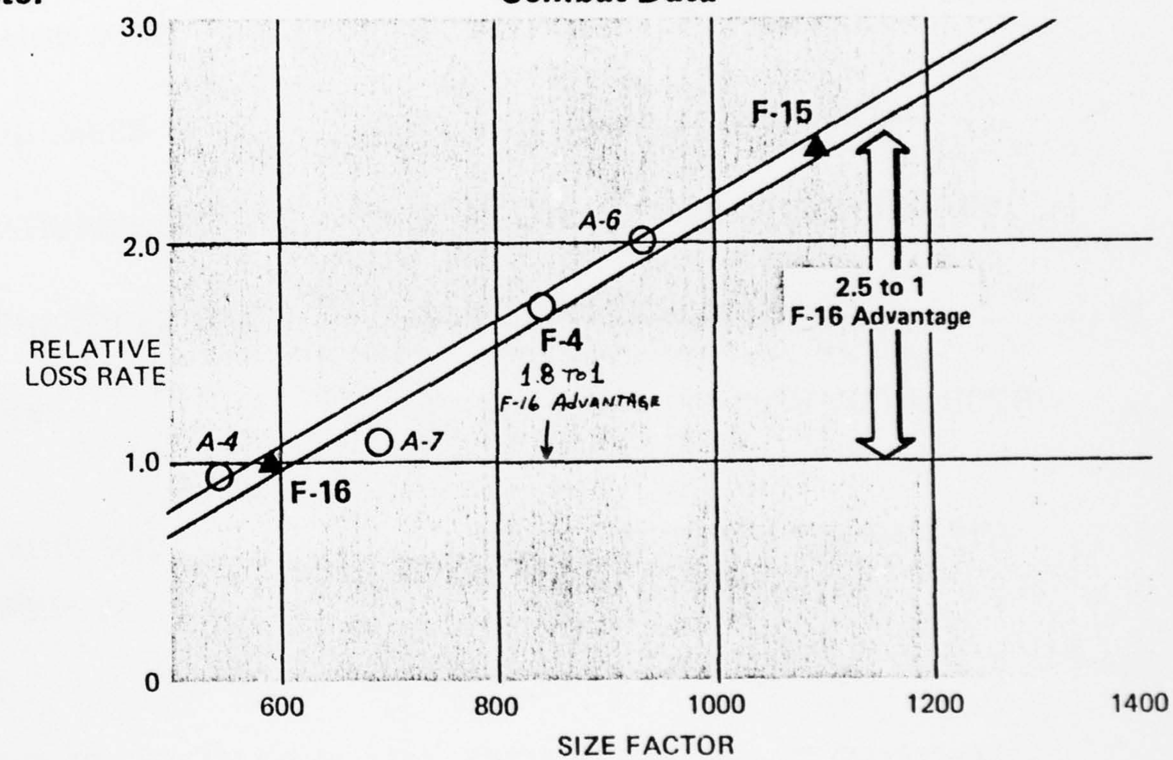
(SMALL SIZE REDUCES HIT FREQUENCY)



Size Factor*

F-16	586
A-4	565
A-7	655
F-4	838
A-6	938
F-15	1107

Combat Data



*Size Factor = $\sqrt{A^2_{Front} + A^2_{Side} + A^2_{Top}}$

- *North Vietnam Strike Missions*
- *Equivalent Mission Risk*

GENERAL DYNAMICS 77 A4791A

Fig 1.

2.

F-16 Is Designed for Survival in Combat

The Ability to **Avoid Being Hit**	The Ability to **Tolerate Damage Given a Hit**
1. SMALL SIZE	1. FLY-BY-WIRE FLIGHT CONTROLS
2. LOW OBSERVABLES	2. REDUNDANT SYSTEMS
3. HIGH PERFORMANCE	3. SEPARATED POWER CHANNELS
4. HIGH AWARENESS	4. EXPLOSION SUPPRESSION
5. PENETRATION AIDS	5. INTEGRAL FUEL TANKS
6. ACTIVE SELF DEFENSE	6. NO HYDRAULIC FLUID IN WING
7. TACTICAL FLEXIBILITY	7. RUGGED 9 'g' STRUCTURE

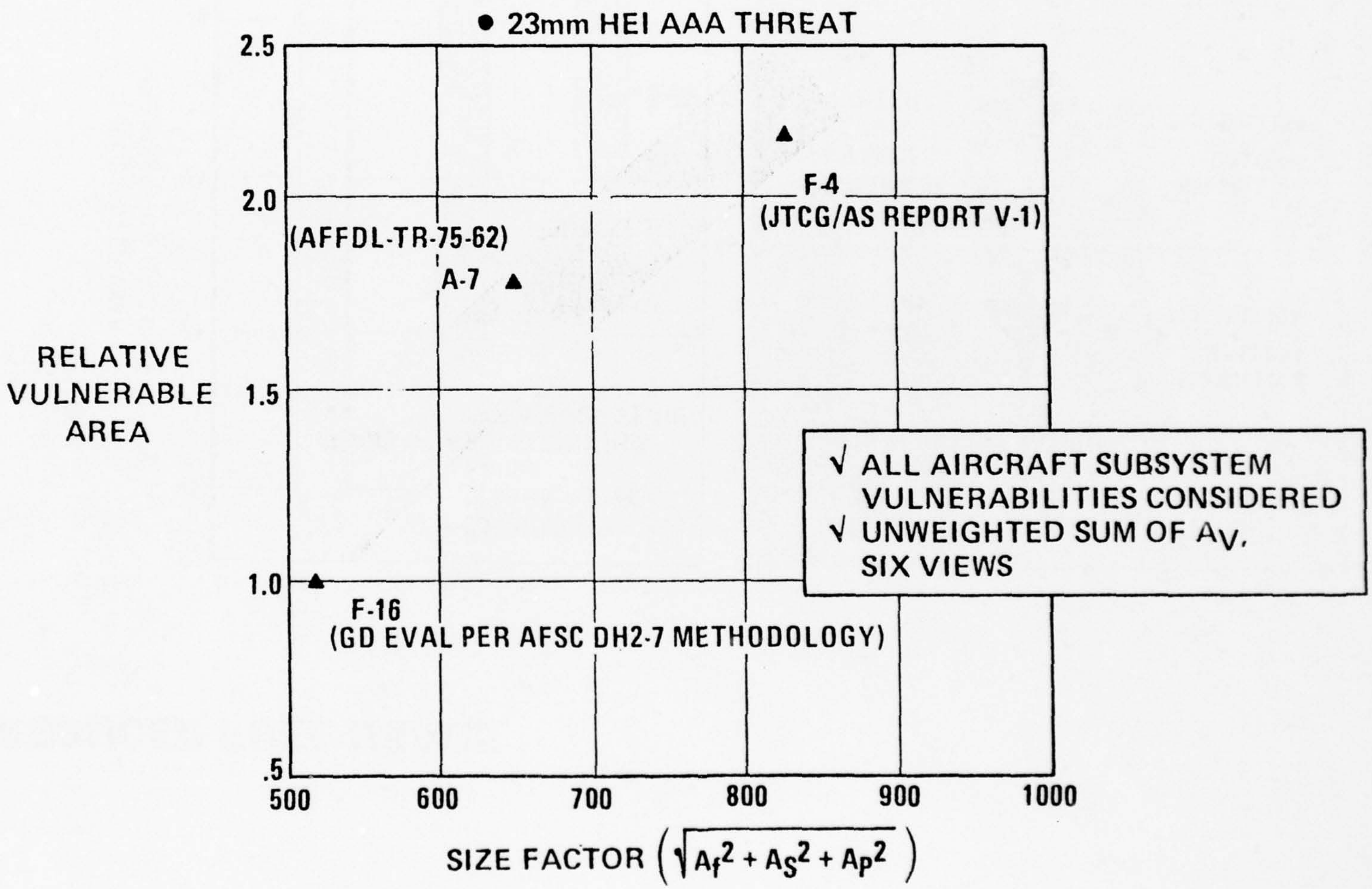
GENERAL DYNAMICS 77 A4790

Fig 2.

3.

F-16 Vulnerable Areas Are Smaller

(Tolerate Damage Given a Hit)

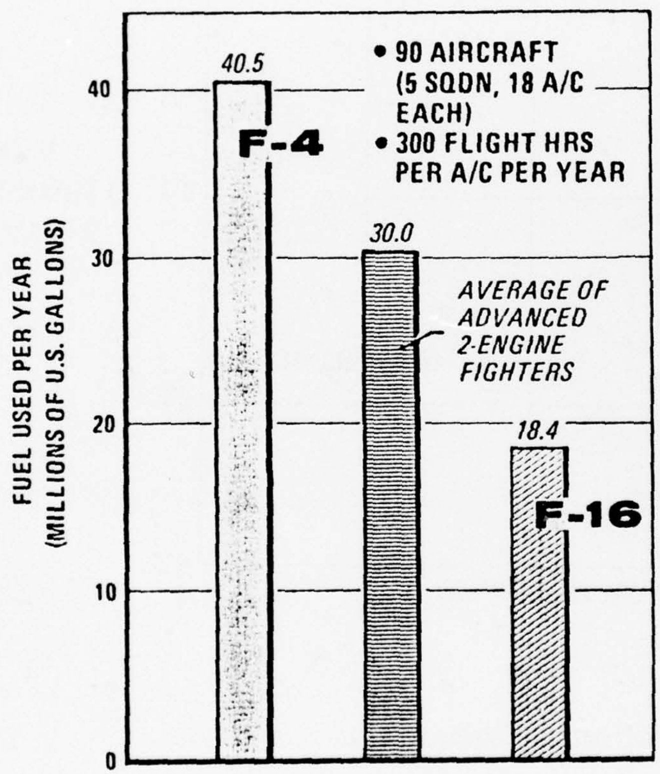


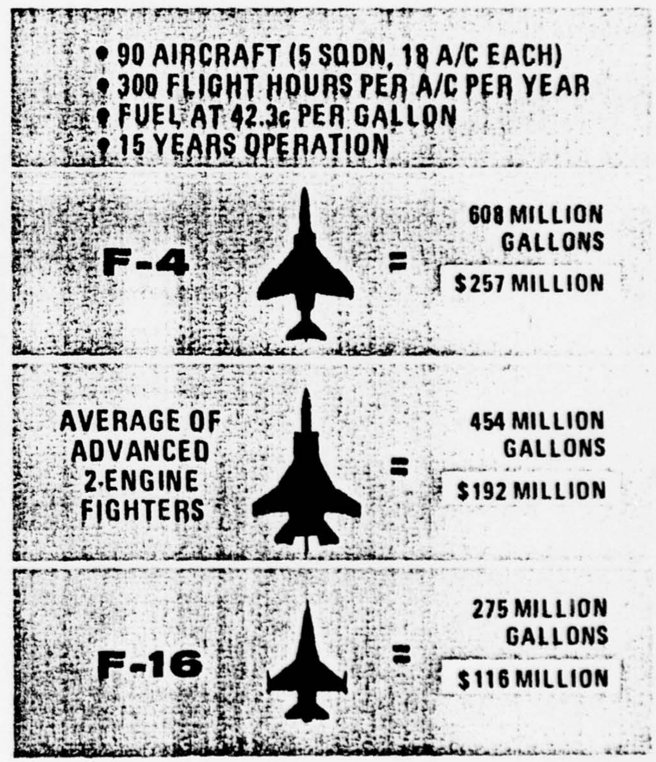
GENERAl DyNAmics 77A4792

Fig

Fig 3.

REDUCED FUEL USAGE





GENERAL DYNAMICS 77 FW/76/100-8342

Fig 4.

FOOTNOTES

1. Alfred Price. Luftwaffe: Birth, Life, and Death of an Air Force. (New York: Ballantine, 1969), p. 57.

2. William Hess. P-51 Bomber Escort. (New York: Ballantine Books, 1971), p. 82.

3. Thomas Clark, General Dynamics, former Wild Weasel project manager, hosted author's visit to General Dynamics. (Fort Worth: Jan 79).

BIBLIOGRAPHY

BIBLIOGRAPHY

Books

Berger, Carl (ed). The United States Air Force in Southeast Asia. Washington, D.C.: Office of the Air Force History, 1977.

Herzog, Chaim, MGen., Israeli Air Force. The War of Atonement. Boston, Toronto: Little, Brown, and Co., 1975.

Hess, William. P-51 Bomber Escort. New York: Ballantine Books, 1971.

Powers, Francis Gary. Operation Overflight. New York: Holt, Rinehart, and Winston, Inc., 1970.

Price, Alfred. Luftwaffe: Birth, Life, and Death of an Air Force. New York: Ballantine, 1969.

Government Documents

Brown, George S., Gen., USAF, Chairman Joint Chiefs of Staff. United States Military Posture for FY 1979. 20 Jan 78.

U.S. Air Force, Technical Order 1F-4G-1 Flight Manual. 1 Oct 77.

U.S. Army, Field Manual 90-1, Employment of Aviation Units in a High Threat Environment. Washington, D.C.: 20 May 77.

U.S. Army, Field Manual 100-5, Operations. Washington, D.C.: 1 Jul 76.

U.S., Congress, House, Committee on Appropriations. Department of Defense Appropriations for 1977, Part 1. Hearings ...94th Congress, 2d sess., Washington, D.C.: Government Printing Office, 1976. Sec of Defense Rumsfeld's prepared statement on F-4G Wild Weasel and EF-111A.

U.S., Congress, Senate, Committee on Armed Services. FY77 Authorization for Military Procurement, Research, and Development, Part 9, Tactical Airpower. Hearings... 94th Congress, 2d sess., Washington, D.C.: Government Printing Office, 1976.
---Review of the Air Force's Combat Aircraft Programs: The F-15, F-16, A-10, and the F-4G Wild Weasel.
---F-4G Wild Weasel Program Review.

U.S. Department of Defense, Annual Report FY72. Washington, D.C.: 1972.

Deskin, George W. "The F-16 Connection." Electronic Warfare, Part 1, The Backgrounder. Jul-Aug 76.

Dietchman, S. J. The Implications of Modern Technological Developments for Tactical Air Tactics and Doctrine. Montgomery: Air University Airpower Symposium, Air War College, Mar 29-31, 1977.

"Electronic Countermeasures Decisive in Typical Combat Strike." Electronic Warfare/Defense Electronics. Jul 78.

"Egyptian Air Defense Command." Electronic Warfare/Defense Electronics, Vol X. Jan 1978.

General Dynamics Corp., Fort Worth Division.
---F-16A/B Facilities, Requirements, and Design Criteria, Vol. 1. Ft. Worth: June 1977.
---F-16 Multirole Figher. Ft. Worth: 1977.
---F-16 Multirole Fighter: Selected Technical Papers. Ft. Worth: May 1977.
---F-16 Multirole Fighter Overview, Vol. 1. Ft. Worth: Aug 1977.
---F-16 Program Summary, Vol. 1. Ft. Worth: Aug 1977.
---F-16 Utilization in Peacetime and Wartime, Vol. 1. Ft. Worth: May 1977.
---Meeting Tactical Fighter Requirements for Near-Term and the Future, Vol. 1. Ft. Worth: Mar 1977.
---USAF/General Dynamics F-16 Program, Vol. 1. Ft. Worth: Sep 1977.

"Goodbye to the Old Generation of Fighters." Interavia. Jul 1978.

Jones, David C., Gen., USAF. "The Evolving Role of Electronic Warfare in the USAF." Illus Electronic Warfare, Vol VII, Mar-Apr 1975.

Lake, Julian S., RAdm, USN(Ret), and Hartman, Richard V., LtCmdr., USN(Ret), "Air Electronic Warfare," U.S. NavalWInstiture Proceedings. Oct 76.

Levy, Larry. "F-16 Fighter Capabilities Limited by Man." Current News, Part 2. Mar 2, 1978.

Marsh, R. T., MGen., USAF, "Electronic Warfare." Air Force Magazine. Jul 78.

"New Weasel Aircraft Will Play a Vital Role." Electronic Warfare/Defense Electronics, Vol X. Feb 78.

"The F-16 Goes Operational." Air Force Magazine. Jan 79.

"Wild Weasels Prepare to Fly the F-4G." Electronic Warfare/Defense Electronics. Feb 78.

Interviews and Correspondence

Beale, Bobby, Colonel, USAF, HQ Tactical Air Command, Directorate of Requirements, telephone interview Apr 79.

Clark, Albert P., III, Maj., USAF, Chief Standardization/ Evaluation, Kadena AB, Japan, 1974. Wild Weasel Pilot, Tactical Fighter Weapons Center, Nellis AFB, Nevada, 1978. Numerous telephone interviews 78 to 79.

Clark, Thomas, General Dynamics former Project Manager for F-16 Wild Weasel. Hosted author's visit to General Dynamics, Ft. Worth, Texas, Jan 79.

Clifford, Thomas E., MGen., USAF, Department of Air Force, Public Affairs, Washington, D.C.

Graff, Peter M., LtC., USAF, Wild Weasel Pilot, Commander 67th Tactical Fighter Squadron, Kadena AB, Japan, 1975-1977. Staff Officer Tactical Air Command, DRAV, Langley AFB, Virginia, 1978.

Hillman, William W., Capt., USAF, Wild Weasel Pilot, Flight Commander/Instructor Pilot, 39th Tactical Fighter Wild Weasel Squadron, George AFB, California, 1978-79.

Johnson, J.O., Maj., USAF, HQ Tactical Air Command, DRWP, Langley AFB, Virginia, 1978.

Taylor, William W., LtC., USAF, Wild Weasel Pilot, present Commander 67th Tactical Fighter Wild Weasel Squadron, Kadena AB, Japan, 1979.

Westerheide, Donald, General Dynamics Project Manager for F-16 Wild Weasel, Ft. Worth, Texas.